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BY

RONALD GOOD

(The University, Hull)

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ON THE GEOGRAPHICAL RELATIONSHIPS OF THE ANGIOSPERM FLORA OF NEW GUINEA

By RONALD GOOD

Introduction

Ever since it was first explored the great island of New Guinea has been generally recognized as a critical part of the world from the point of view of many biological problems, and especially of those relating to the sequence of events by which the gradual population of the world by its plant and animal inhabitants has come about. Yet it has, until comparatively recently, remained little known in comparison with the regions to the north-west, west and south of it. New Guinea is a land of very prominent relief, with much dense forest, and this together with the hostility of many of the native peoples formerly made access to the interior slow and difficult except along some of the rivers, so that for a long time our knowledge of the flora and fauna was scarcely more than representative of the peripheral areas. In the last thirty years, however, three circumstances have combined to hasten the opening up of the country in a remarkable way. In chronological order these are the rapid development of gold-mining some thirty years ago ; the harsh necessities of war ; and the development of air transport. It is particularly the latter which has brought about the latest and most interesting phase of penetration, the exploration since the war of the large and densely populated valleys of the interior highlands. There is, of course, still much to be learned about the plants and animals of New Guinea, and no doubt many important discoveries remain to be made, but we have now, for the first time, a fairly adequate picture of the biology of the island as a whole and can claim with some justification that, although this picture may still need much filling in, its outlines are reasonably clear.

In view of what has been said, and also because New Guinea has never been wholly under the control of a single administration, it is not surprising that the literature of the flora, though copious, is scattered and little co-ordinated. The great *Flora Malesiana* now in preparation will, it is expected, eventually provide a Flora of the island by extraction, but there is nothing of the sort at present. The material on which to base a geographical analysis of the flora has therefore to be culled from many sources, prominent among them being innumerable papers dating from the days of German rule in Kaiser Wilhelms Land ; articles on particular groups, many of them by Dutch workers ; and extensive collections which have been greatly augmented in the last twenty-five years.

Studies of the New Guinea flora with the hope of revealing its degree of relationship with those of various other countries have from time to time been made, but with the one exception of a paper by H. J. Lam (" Materials towards a study of the flora of the island of New Guinea ", in Blumea i : 115–159 (1934)) these have not been very penetrating or detailed. Even Lam's analysis does not, in all respects, cover the

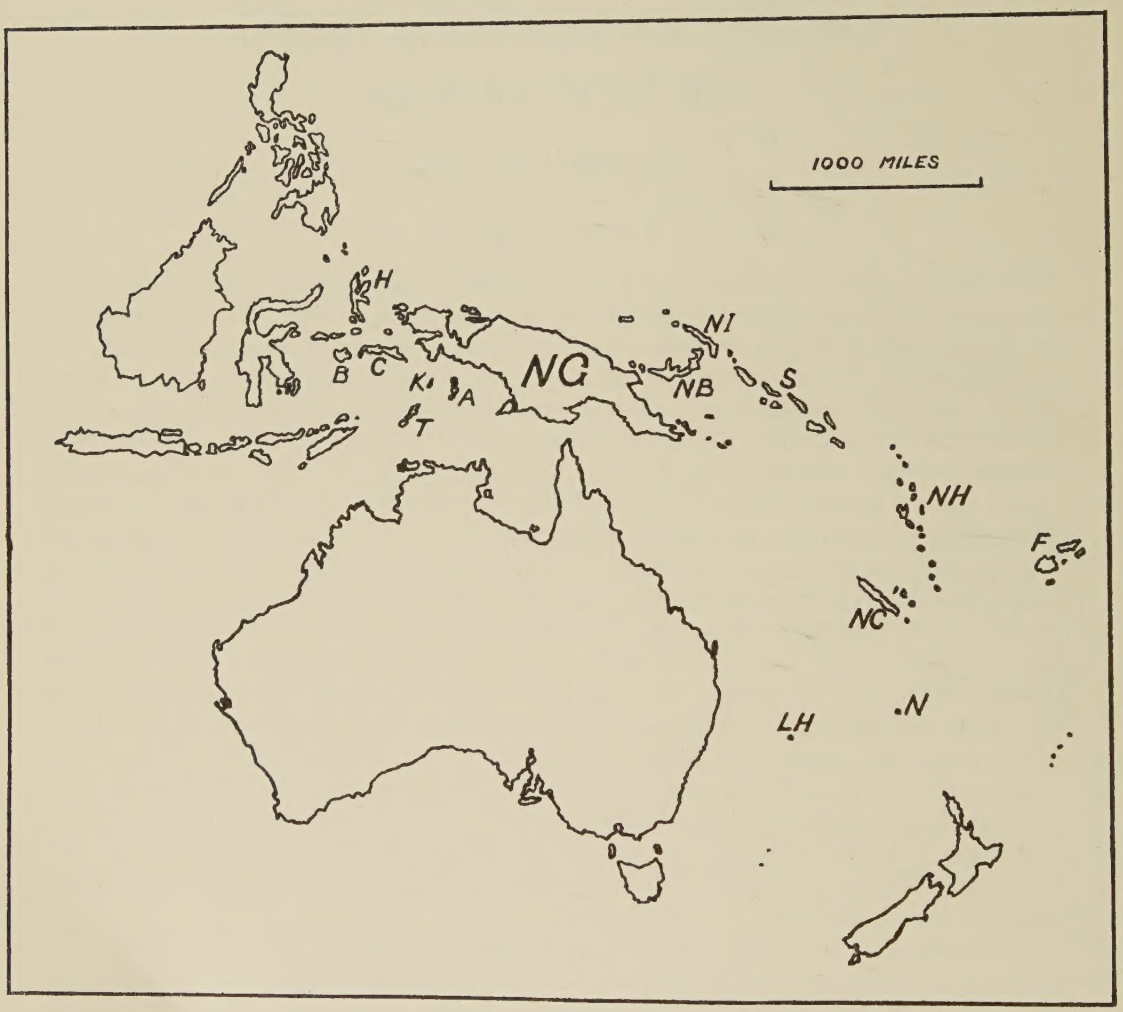

FIG. 1. Sketch-map showing the position of the island of New Guinea (NG) in relation to Malaysia on the west; to the rest of Melanesia on the east and south-east; to Australia on the south; and to New Zealand. Among New Guinea's nearest neighbours west and east are the Moluccan islands of Halmahera (H), Ceram (C) and Buru (B); the Aru Islands (A), the Kai Islands (K) and Tanimbar (T); New Britain (NB), New Ireland (NI) and the Solomon Islands (S). Further south-east are the New Hebrides (NH), New Caledonia and the Loyalty Islands (NC), Fiji (F), Lord Howe Island (LH) and Norfolk Island (N).

whole of the Flowering Plants, but it is a valuable paper, not only as a source of facts and figures but because it contains an ample survey of the literature of the New Guinea flora up to its date. On this score all that need be added here is to say that most of the serial publications referred to there (including *Blumea* itself) still continue, and that there are two major subsequent sources, namely the *Flora Malesiana* already mentioned, and the series of papers, mainly in the *Journal of the Arnold Arboretum*, primarily describing the great collections made by the Archbold and other expeditions during the later inter-war years. Among shorter recent publications *The Forests and Forest Conditions in the Territories of Papua and New Guinea*, by J. S. Womersley and J. B. McAdam (Government Printer, Port Moresby, 1957), gives a particularly useful outline of the plant life of the island.

The need for a more complete appreciation of the geographical affinities of the New Guinea flora has become more pressing because of the progress which has been made recently in many aspects of the geological and geographical histories of the countries of Australasia. Among these countries New Guinea occupies a highly strategic position (Fig. 1), marking the junction of Malaysia (peninsular and insular tropical south-east Asia), Melanesia (of which it is often reckoned the chief constituent) and Australia. Because of the shallowness of the Arafura Sea, which separates west New Guinea from the Northern Territory of Australia, and the number of small islands or reefs actually in the Torres Strait its link with Australia has always seemed particularly close, but its distance from the Moluccan island of Ceram (Seram) on the west is little greater, though the intervening water is much deeper. From its nearest Melanesian neighbour, New Britain, it is separated by scarcely half these distances.

The special geographical problem of the New Guinea flora is that of determining, both quantitatively and qualitatively, and as closely as may be possible, the degree of relationship between it and the flora of Australia. This is because, although the two regions are now almost completely linked physically, nowhere else in the world is there, over a similar distance, so great a difference in both plant and animal life as there is between the island of New Guinea and the continent of Australia.

Unfortunately this problem has become slightly confused by several more or less irrelevant circumstances. First, Australia was explored botanically earlier than was New Guinea so that many of the genera, and even species, which have been found subsequently to occur in both are commonly thought of and described as " Australian " types, though there may be nothing in the facts to justify this epithet. Second, the flora of New Guinea was for long known principally from the coastal zone only, where the vegetation is most under human influence and where widespread plants are especially in evidence. Third, the most accessible part of New Guinea, southern Papua, is nearest, as well as climatically most similar, to parts of Australia, so that its flora tends to contain not only a larger than average admixture of native plants of Australian affinity, but also introductions from that continent. Besides these there is the rather different point that the more clearly any considerable Australian element can be shown to exist in the New Guinea flora the less puzzling the general problem of the relationship between the two becomes. All these circum-

stances have tended in the past to exaggerate the importance of the Australian element in the New Guinea flora, and a fresh assessment in the light of our increased knowledge is much to be desired.

It is clearly impossible, without embarking on a prolonged taxonomic study for which the time is probably not yet ripe, to make a statistical analysis of the New Guinea flora right down to species level, but for the re-presentation of the geographical facts of the flora in the light of the recent additions to our knowledge of it, it is enough to go no further than genera, taking species into account only when to do so is particularly revealing (see further remarks on p. 220). The basis of the analysis here is therefore a list of all the genera which have been recorded from New Guinea, either in literature or by personal record. In order to avoid complicating any issues unnecessarily the list refers only to the mainland of New Guinea proper and does not comprehend any of the other islands which may be included in the name Papuasia. The compilation of this list has been greatly facilitated by the prior existence of two similar but independent lists made for more general purposes, one at Leyden and one at the headquarters of the Botany Division at Lae in New Guinea. Thanks to the generous co-operation of Dr. P. van Royen and Mr. J. S. Womersley respectively I have been able to compare mine with these two lists, with great advantage to my own and, I hope, some benefit to the others also. Since the former list is likely to have the widest employment of the three it has been followed here as far as possible without thereby losing sight of any facts of special phytogeographical significance.

It must be emphasized here that neither the list of genera nor the innumerable figures derived from it which appear in the following pages are to be regarded as in any way definitive. They are simply the nearest approximations that it is practicable to make in the present state of our knowledge of the New Guinea flora and every fresh discovery will inevitably modify one or more of them slightly. For this reason it has been thought best to quote them as compilation actually reveals them rather than to round them off in any way, and the apparent exactitude of some of them is not intended to suggest that they are outstandingly accurate. These remarks apply even more strongly when species numbers are quoted.

The Flora of New Guinea

The total number of generic names under which species of the Flowering Plants have been recorded from New Guinea is about 1,850, but this includes not only a number of synonyms but also the names of many plants deliberately or accidentally introduced.

From the point of view of this analysis there are two kinds of synonymy. One is the application of two or more different names to the same plant, and this is not a great problem since it is only necessary to ensure that no plant is considered more than once. The second kind arises from differences of taxonomic opinion by which some workers have recognized more and smaller genera than others, and this can be dealt with only by trying to steer a reasonable course between undue lumping on the one hand and undue splitting on the other. This has as far as practicable been done, and

the result is to exclude about 275 names as synonyms and so to reduce the list to about 1,575.

The question of the status of all these genera in New Guinea is much more difficult. In trying to trace the origins and natural relationships of any flora it is essential, as far as possible, to eliminate from consideration plants which have come into the country through human agency and to consider only those which are truly indigenous, that is to say which either existed in the country before the advent of man, or may have entered it since entirely by means unconnected with man's presence, and to recognize these indigenes or natives is not always easy.

Some genera, such as *Ananas*, *Carica* and *Zea*, are obvious deliberate introductions, but others, such as *Boehmeria*, *Cananga*, *Cassia* and *Crateva*, are more doubtful. Many genera occur wholly or especially as weeds and the casual introduction of these seems very probable, though we cannot be sure in all cases, because if a plant is well known in cultivation or as a weed it may nevertheless be a native of New Guinea, as is the case with *Graptophyllum* and *Codiaeum*, now widely familiar in the tropics. Even the description of endemic species is not necessarily evidence that a genus is indigenous, because some such species are most probably no more than local variants of introduced plants. Nor is the absence of endemics indicative of introduction, for there are many indigenous genera represented in the flora only by species occurring elsewhere as well as in New Guinea.

Speaking generally there can be little doubt that the proportion of genera which do in fact owe their presence to the direct or indirect action of man is considerably higher than is usually supposed. Even in the deep interior of the island, where human activity long antedated the coming of European man, there are great extents of grassland which can confidently be regarded as replacements of original forest. Nor is it possible to estimate how long this modification has been going on for there are to be found here the remains of older human cultures quite unknown to the present native peoples. It may indeed be that many of the plants in such situations, though they seem quite at home there, do owe their presence to man. At least we can be sure that the number of introductions has risen sharply in the last hundred years or so, and that it is constantly increasing, making it more and more unlikely that the problem of status will ever now be solved altogether satisfactorily. It is to be remembered too that there must also be classed as introductions those plants which, without man's prior presence in the island, could never have found there the conditions they require. Some of the grasslands just mentioned perhaps had no counterpart in pre-human times and the plants in them may in fact be almost all adventive.

There is perhaps no greater obstacle to the better understanding of the geographical floristic relationships of the world than this problem of recognizing status, and all the indications suggest that it has been much underestimated in the past and the proportion of indigenous genera and species unduly magnified. Here I have treated about 225 genera as being either deliberate or casual introductions of one sort or another. This number is almost certainly smaller than it should be but is as satisfactory as possible in the absence of more evidence.

Thus, after deducting the synonyms and the non-native genera, we are left with a

list of 1,350 genera representing what may be called the aboriginal or indigenous and native flora of New Guinea proper, and it is with these genera alone that the following pages are concerned.

Analysis of the indigenous genera of New Guinea

1. *Distribution by families*

(See also Table II)

The 1,350 genera with one or more indigenous species in New Guinea are distributed over some 200 families, or rather more than half of all Angiosperm families, but very unevenly. Of the largest families only the *Labiatae* appear to include no indigenous species, though endemics have been described in more than one genus. The absence of this family is a remarkable feature of the flora, especially since there is a whole group of the family peculiar to Australia. The family *Amaranthaceae* is also entirely unrepresented by indigenous species if a single species which occurs also in Australia is an introduction. In the *Convolvulaceae*, and to a less degree in the *Compositae* and *Cucurbitaceae*, the introductions outnumber the indigenes. Among smaller families unrepresented are the *Phytolaccaceae*, generally widely spread in the tropics ; the *Cytinaceae*, for which there would seem to be many possible habitats in New Guinea ; and the *Balanopaceae*, known from New Caledonia and Queensland. All three of these may yet be found.

There are no endemic families in New Guinea. About 60 families are represented only by wide (i.e. non-endemic) species. In 75 families there is only one indigenous genus, and in just over half of these there is only one species, more often than not a wide.

From the point of view of a geographical survey the three types of family representation particularly prominent and noteworthy are :

A. *Large families with a strong proportion of endemic species, and usually numerous genera*, namely *Annonaceae, Apocynaceae, Araceae, Asclepiadaceae, Ericaceae* (including *Vacciniaceae*), *Euphorbiaceae, Gesneriaceae, Melastomataceae, Myrtaceae, Orchidaceae, Palmae, Rubiaceae, Rutaceae, Sapindaceae, Sapotaceae, Sterculiaceae, Urticaceae, Verbenaceae, Zingiberaceae.*

These may be regarded as furnishing the bulk foundation of the flora, and absolutely outstanding among them is the family *Orchidaceae*, which with some 128 genera and over 2,600 species, practically all of them endemic, provides the most remarkable single characteristic of the flora as a whole.

B. *Large families with a small proportionate representation of endemic species or none at all*, such as *Compositae, Gramineae, Leguminosae, Scrophulariaceae*, and on a less striking scale *Boraginaceae, Commelinaceae, Cyperaceae, Juncaceae.* In the first three, especially, there are large numbers of introductions and there is a particularly notable contrast between the *Gramineae* and the *Orchidaceae* already mentioned above, the former, though represented by over 80 genera, having only about 70 endemic species. It may be noted, moreover, that the question of status is particularly difficult in the grasses, and the number of truly indigenous genera may well be even smaller than has been assumed.

The contrast of these families with those of A above is another leading character of the flora and one of its most notable negative features.

C. *Smaller families with a notably high proportionate representation and many endemics.* The most important of these are *Araliaceae, Cunoniaceae, Elaeocarpaceae, Icacinaceae, Lauraceae, Loganiaceae, Loranthaceae, Meliaceae, Menispermaceae, Monimiaceae, Moraceae, Myrsinaceae, Opiliaceae, Winteraceae.* Three others of a slightly different kind reinforce these, namely *Begoniaceae*, with about 70 species in two genera ; *Symplocaceae* with about 30 species in one genus ; and *Saurauiaceae* with about 80 species in one genus. It is to these families that many of the most characteristic and ecologically prominent members of the flora belong.

The following two lists show in concise form a number of other features in the representation of families :

1. *Families with 20 or more indigenous genera, with approximate numbers of endemic species in parentheses*

Orchidaceae	128	(2,600)	*Acanthaceae*	25	(45)
Gramineae	82	(85)	*Apocynaceae*	25	(84)
Leguminosae	64	(100)	*Cyperaceae*	24	(75)
Rubiaceae	62	(620)	*Annonaceae*	23	(85)
Euphorbiaceae	39	(192)	*Compositae*	22	(77)
Palmae	32	(255)	*Araceae*	21	(106)
Myrtaceae	28	(273)	*Menispermaceae*	21	(26)
Melastomataceae	27	(138)	*Rutaceae*	21	(110)
Sapindaceae	26	(108)			

2. *Families in which more than 100 endemic species have been described*

Orchidaceae	2,600	*Urticaceae*	146
Rubiaceae	620	*Lauraceae*	145
Ericaceae	311	*Melastomataceae*	138
Myrtaceae	273	*Asclepiadaceae*	125
Palmae	255	*Myrsinaceae*	116
Zingiberaceae	195	*Pandanaceae*	110
Euphorbiaceae	192	*Rutaceae*	110
Elaeocarpaceae	187	*Sapindaceae*	108
Gesneriaceae	182	*Araceae*	106
Moraceae	171	*Piperaceae*	103
Meliaceae	164		

2. *Geographical distribution of the genera*

(See also Tables I and II)

A survey of the indigenous New Guinea genera on the basis of their geographical distributions outside that country shows that they can be classified into eight main categories, namely :

a. Widespread, and often predominantly temperate, genera.
b. Pantropical genera.
c. Palaeotropical genera.

d. Genera of the Asiatic-Australian and American tropical sectors only.
e. Indomalaysian genera.
f. Australian genera.
g. Remaining non-endemic genera.
h. Endemic genera.

a. Widespread, and often predominantly temperate, genera

These number about 86 and include wide aquatic or subaquatic genera such as *Carex, Juncus* and *Lemna* ; such grasses as *Agrostis* and *Festuca* ; and orchids such as *Habenaria* and *Spiranthes* ; but the majority of them are mainly or entirely temperate genera. Of these latter it is particularly noteworthy that *Clematis, Cotula, Epilobium, Euphrasia, Gaultheria, Myosotis, Ranunculus* and *Wahlenbergia* provide some of the most characteristic members of the New Zealand flora. It may be added that in the genus *Plantago* (and its family) the only non-endemic species out of four occurs elsewhere only in New Zealand.

b. Pantropical genera

The pantropical genera number in all about 244. In some three-quarters of them the number of endemic species is less than five. Many of these are probably not truly indigenous, but the following may be given as examples :

Bauhinia, Combretum, Connarus, Ehretia, Erythroxylum, Hibiscus, Hippocratea, Homalium, Justicia, Parkia, Passiflora, Rauvolfia, Rinorea, Ruellia, Securidaca, Uvaria, Zanthoxylum.

In the other 60 or so genera the numbers of endemic species run up to over 500, the most notable examples being :

Bulbophyllum (558), *Eugenia* (*sensu lato*) (180), *Ficus* (150), *Elaeocarpus* (120), *Psychotria* (120), *Malaxis* (*Microstylis*) (89), *Piper* (86), *Begonia* (60), *Schefflera* (55), *Cryptocarya* (47), *Calanthe* (38), *Ardisia* (37), *Ixora* (32), *Solanum* (32), *Symplocos* (31).

c. Palaeotropical genera

The palaeotropical genera number 169 in all and again in about three-quarters of them the number of endemic species is less than five. Examples of these are :

Alangium, Amorphophallus, Antiaris, Borassus, Bridelia, Callicarpa, Cassytha, Ceropegia, Cirrhopetalum, Exacum, Flacourtia, Flagellaria, Grewia, Mangifera, Myrsine, Olax, Pavetta, Phaius, Pterygota, Rungia, Tylophora, Ventilago.

Outstanding among the forty or so genera with more than five endemic species are :

Oberonia (84), *Medinilla* (64), *Calamus* (57), *Garcinia* (55), *Pandanus* (51), *Macaranga* (46), *Evodia* (45), *Myristica* (38).

d. Genera of the Asiatic-Australian and American tropical sectors only

These number in all only 27 but the category is an interesting one in comparison with the palaeotropical (African and Asiatic-Australian) category already mentioned. The genera, with the numbers of their endemic species, are :

Saurauia (84), *Eurya* (20), *Homalomena* (17), *Weinmannia* (12), *Erythrodes*

(*Physurus*) (9), *Perrottetia* (6), *Meliosma* (3), *Gordonia*, *Astilbe*, *Sapindus* and *Turpinia* (2 each), *Anotis*, *Antirhea*, *Erechthites*, *Gymnopogon*, *Muhlenbergia*, *Phrygilanthus*, *Spathiphyllum* and *Talauma* (1 each), and *Nelumbo*, *Laplacea* and *Lespedeza* with none. To these are to be added five slightly aberrant genera: *Ternstroemia* (10) which has one species in Angola and one in Tanganyika Territory; *Clethra* (1), with a species in Macaronesia; *Coriaria* (1) and *Styrax* (1), each with a species in Europe; *Cynoctonum* (0), with two species in Madagascar. It is to be noted that four of these genera belong to the comparatively small family *Theaceae*, and that *Weinmannia* and *Coriaria* are found in New Zealand.

e. Indomalaysian genera

Under the term " Indomalaysian " are included all the genera whose distributions are predominantly outside, and to the west and north-west of New Guinea, as far, it may be, as India or China or Japan. It thus includes such distributions as from India to Polynesia and New Zealand, that is to say " Indo-Australasian " in the widest sense, or much more narrowly from some part of the western Malaysian Archipelago to New Guinea, such as is often described as " Malaysian ". Thus the category is susceptible to much fine division in detail, and this is well, because it is by far the largest geographical category in the flora, containing 494 genera, many of them well represented by endemic species. About one-fifth of these are " Malaysian" rather than " Indomalaysian " in the above sense.

Twenty-six of the genera included here have in fact been recorded, usually as a single species, from some part of the Madagascar Region, but some of these involve the question of status there and it has been thought unwise to separate them as a distinct category. They are :

Agrostophyllum, *Alyxia*, *Amaracarpus*, *Atylosia*, *Calpidia*, *Cerbera*, *Dimeria*, *Erythrospermum*, *Galeola*, *Geniostoma*, *Garnotia*, *Hedychium*, *Lepironia*, *Melastoma*, *Nepenthes*, *Orchipeda*, *Pipturus*, *Pothos*, *Samadera*, *Schizostachyum*, *Strobilanthes*, *Strongylodon*, *Thoracostachyum*, *Thuarea*, *Timonius*, *Zoysia*.

It is to the Indomalaysian category that many of the genera with the largest numbers of endemic species belong, among notable examples being :

Cyrtandra (97), *Aglaia* (70), *Alpinia* (68), *Riedelia* (65), *Freycinetia* (59), *Hoya* (59), *Timonius* (57), *Dimorphanthera* (55), *Hydnophytum* (52), *Dysoxylum* (46), *Helicia* (41), *Ophiorrhiza* (40), *Licuala* (34), *Chisocheton* (33), *Fagraea* (31), *Aeschynanthus* (30), *Litsea* (30),

and the following genera of *Orchidaceae* :

Dendrobium (619), *Phreatia* (114), *Taeniophyllum* (88), *Eria* (71), *Glomera* (71), *Ceratostylis* (63), *Agrostophyllum* (45), *Mediocalcar* (36), *Glossorhyncha* (35), *Microtatorchis* (34), *Appendicula* (32), *Podochilus* (30).

f. Australian genera

Broadly speaking, the facts and categories so far discussed are among the more familiar concerning the New Guinea flora. Much the same is true of the category of endemic genera to be dealt with a little later, but with the other two categories,

the " Australian " and the " remaining non-endemic " genera, to which we must now pass, the situation is rather different and it is chiefly with these that some misconceptions have arisen in the past. Their consideration therefore calls for some preparatory comments.

The first concerns the meaning, in this connexion, of the word " Australian ". There is little doubt as to the intended implication of the word, namely that genera so called are genera of Australian origin and particularly characteristic of the flora of that continent. Unfortunately there is seldom, if ever, any direct evidence for the place of origin of a genus, and we can therefore only assume such to be the case on collateral evidence. This evidence too is difficult to find and unconvincing when it is found, so that we are in practice reduced to some more arbitrary definition, such, for example, as that " Australian " genera are genera of which the bulk of the species are members of the flora of Australia and which have a wider range within that continent than outside. It will probably be agreed that this is as near a definition of an " Australian " genus as it is possible to get, and when that geographical adjective is used here this is the intended meaning of it. The only ready alternative to this would be to call " Australian " all genera occurring in that continental flora irrespective of their distribution or numbers of species outside and this would manifestly be unreasonable. We may therefore accept that a genus meriting the description " Australian " is one in which the bulk of the species are found in Australia and, generally, whose distribution within that continent is greater, or at least more concentrated, than it is outside.

When this definition is carefully applied to the 1,350 or so indigenous genera of New Guinea it will be found that only 62 genera conform to it. Not only so but the details relating to the occurrence of some of these in New Guinea suggest that they have little real claim to be so regarded. These are important conclusions because, for the reasons mentioned earlier, there has long been an understandable tendency to think of the Australian element (as it may be called) in the New Guinea flora as something more considerable than it really is, and this has in turn lent false colour to some speculations about the origins and relationship of the floras of the two regions. It is therefore very desirable that the relevant facts about the occurrence of these 62 genera should be stated as clearly as space permits, and the following review of them is for this purpose. Lest any unwarranted implications should accidentally arise they are dealt with alphabetically. These genera are :

Acacia (*Leguminosae*). Widely tropical in distribution but very characteristic of and well represented in the Australian flora, where there are hundreds of endemic species. Five species have been recorded from New Guinea of which *A. pennata* is a wide Old World species ; *A. manglesii* is also in Malaysia and Australia ; and the other three are in Australia also. *A. pseudoarabica* is apparently not maintained as a New Guinea endemic.

Agonis (*Myrtaceae*). A genus allied to *Leptospermum*. One, or perhaps more, of the 12 or so Australian species occurs also in New Guinea.

Arthropodium (*Liliaceae*). A genus with five species in Australia ; one in Australia and New Guinea (*A. strictum*) ; three in New Zealand and one in New Caledonia.

Backhousia (*Myrtaceae*). A genus with about seven species in Australia, mostly in the Queensland rain-forests, and two in New Guinea.

Baeckea (*Myrtaceae*). This genus ranges from south-east Asia to New Caledonia (where

there are several endemics), but the great majority of the 100 or so species are in Australia. One wide species is recorded for New Guinea.

Banksia (*Proteaceae*). A characteristic Australian genus of about 50 species; represented in New Guinea only by *B. dentata*, which is also in northern Australia.

Brachychiton (*Sterculiaceae*). Usually quoted as wholly Australian, and with several species in the Queensland rain-forests, but *B. carruthersii* has been described from New Guinea. This species however has also been included in *Sterculia*, a wide tropical genus.

Brachycome (*Compositae*). A genus placed near *Bellis*, *Lagenophora* and *Myriactis*. Predominantly Australian (about 40 species), but there are five species in New Zealand, two in New Caledonia, and one, endemic, in New Guinea.

Caesia (*Liliaceae*). One of the six Australian species has fairly recently been recorded in Malaysia, including New Guinea, and there are also three species in South Africa.

Calogyne (*Goodeniaceae*). A characteristic genus in Australia, where there are eight species. One of these extends through New Guinea and the Philippines to south-east Asia.

Casuarina (*Casuarinaceae*). Mr. L. A. S. Johnson (in litt.) recognizes two easily distinguished groups of this genus, one entirely Malaysian–Melanesian except for a single very restricted species in north-east coastal Queensland; the other mainly Australian but found also in Java, Celebes, the Lesser Sunda Islands, New Guinea and New Caledonia. He makes 66 species in all (some yet undescribed) and about 40 of these are confined to Australia, more than half of them to the south-west. Seven species occur in New Guinea, four of them belonging to the first part of the genus, and three of them to the second. Two of them, one from each part, are endemic to New Guinea, the others occurring elsewhere in Malaysia also. One of these, the widely distributed and often planted *C. equisetifolia*, is the only species common to Australia and New Guinea.

Centrolepis (*Centrolepidaceae*). More than 30 of the species are Australian, one of them being in New Zealand also. The genus is also in Tonkin, Borneo, the Philippines and New Guinea. The last-named has two species, one of them also in Australia and the other also in Malaysia.

Ceratopetalum (*Cunoniaceae*). This genus has five species in Queensland and New South Wales in rain-forests, and one of these has been recorded from New Guinea.

Citriobatus (*Pittosporaceae*). One of the four species of this small Australian genus has recently been recorded from New Guinea, Celebes and the Philippines.

Cladium (*Cyperaceae*). A very widespread genus but with most of its 30 species in Australia. The New Guinea representatives of the genus include five endemic species.

Cleistochloa (*Gramineae*). One of the two species of this Queensland grass genus has recently been recorded from New Guinea.

Daphnandra (*Monimiaceae*). This genus has six species, four in Australia, mostly in rain-forests, and two in New Guinea. It is closely related to *Atherosperma* (characteristic of Tasmanian rain-forest) and allied also to *Laurelia* of New Zealand.

Dissiliaria (*Euphorbiaceae*). A genus of three species in Australia, of which *D. tricornis* has recently been recorded also from New Guinea.

Dodonaea (*Sapindaceae*). There is one pantropical species which, together with a single endemic, has been recorded from New Guinea, but almost all the 50 or so others are in Australia.

Drakaea (*Orchidaceae*). An Australian genus of four species of which one (*D. irritabilis*) has recently been recorded from New Guinea.

Drosera (*Droseraceae*). A genus of almost world-wide distribution and particularly well represented in Australia where there are most of its 90 species, especially in the south-west. Six species are recorded from New Guinea. One of these, *D. petiolaris*, is also in northern Australia, but the others—*D. burmanni*, *D. indica*, *D. spathulata*, *D. peltata* and *D. rotundifolia*—are wide species without any special Australian affinity.

Ectrosia (*Gramineae*). An Australian genus of some 12 species, one of which is also in New Guinea.

Epacris (*Epacridaceae*). A genus with about 45 species in Australia, one of which is also

recorded from New Guinea. There is also one species in New Zealand and New Caledonia, and one in New Zealand only.

Eucalyptus (*Myrtaceae*). The genus is overwhelmingly Australian, with several hundred species there, but it occurs as far north as the Philippines. Nine species are found outside Australia. Of the seven of these which are in New Guinea, four are also in Australia ; one may be endemic ; *E. degluptus* is also in the Philippines but not in Australia ; while *E. albus* is also in Timor, Wetar, Flores, Sumba and north Australia.

Exocarpus (*Santalaceae*). A genus of about 20 species, half of them in Australia and the rest ranging over New Zealand, Norfolk Island, eastern Malaysia, the Bonin Islands, New Caledonia and Hawaii. Of the three species in New Guinea two are endemic and belong to a section elsewhere only in the Moluccas; the third belongs to the subgenus in which are most of the Australian species and may occur there also.

Fenzlia (*Myrtaceae*). A genus closely related to *Myrtella* and *Rhodomyrtus*, with four Australian species, one of which has been recorded also from New Guinea.

Flindersia (*Rutaceae*). Fifteen of the 20 species of this genus are in Australia, mainly in rainforest, but there are three endemics in New Guinea, one in New Caledonia and more than one in Amboina.

Gahnia (*Cyperaceae*). This genus ranges from China and Japan, through Malaysia, to Australia, New Zealand, Hawaii and Rapa (Oparu). About half its 40 species are in Australia, and it is well represented also in New Zealand and Hawaii. Only one wide Malaysian species occurs in New Guinea.

Geijera (*Rutaceae*). A genus with about 6 species in Australia, one of which, *G. salicifolia*, has recently been recorded from New Guinea. There is one species in Australia and New Caledonia, and two others are in New Caledonia only.

Geitonoplesium (*Liliaceae*). A genus of perhaps only a single species which occurs in Australia, New Guinea and New Caledonia.

Gompholobium (*Leguminosae*). A characteristic Australian genus of 25 species, one of which, *G. nitidum*, has recently been recorded in New Guinea.

Grevillea (*Proteaceae*). A large and characteristic Australian genus of about 200 species, known elsewhere in Celebes (one species), New Caledonia (12 species) and New Guinea, where there are one endemic species (*G. papuana*) and two which occur also in Australia.

Haemodorum (*Haemodoraceae*). A characteristic Australian genus of about 20 species, mostly in the north of the continent. One of the earlier-described Australian species has been recorded from New Guinea.

Haloragis (*Haloragaceae*). A genus of about 80 species ranging from India and Japan, through Malaysia, to Australia, New Zealand, Rapa and Juan Fernandez. About three-quarters of the species are in Australia. New Guinea has six endemics and two wide species.

Helichrysum (*Compositae*). A large and widely distributed Old World genus particularly well represented in South Africa and Australia and to a lesser degree in New Zealand. The four New Guinea species often attributed to it have been considered to form an endemic genus (*Hecatactis*).

Hibbertia (*Dilleniaceae*). A large and predominantly Australian genus with about 100 species in the continent. There are also 18 in New Caledonia, one in Fiji and one in Madagascar. In New Guinea it is represented by two of the Australian species only, *H. banksii* and *H. scandens*, an earlier-described endemic being no longer maintained.

Keraudrenia (*Sterculiaceae*). A genus usually described as having seven species in Australia and one in Madagascar. One (or possibly two) of the Australian species has been reported from New Guinea.

Lechenaultia (*Goodeniaceae*). There are about 20 Australian species of this genus, one of which has been reported in New Guinea.

Lepidosperma (*Cyperaceae*). The genus ranges from south-east Asia to New Caledonia and New Zealand, but nearly all the 40 species are in Australia. One wide species is recorded from New Guinea.

Leptocarpus (*Restionaceae*). A genus with about a dozen species in Australia, one in Cochin

China, one in New Zealand and one in Chile. One of the Australian species, *L. elatior*, occurs in New Guinea.

Lomandra (*Liliaceae*). A genus of some 30 Australian species of which one is also in New Guinea and New Caledonia.

Melaleuca (*Myrtaceae*). One species ranges from south-east Asia to New Caledonia, including New Guinea, but there are well over 100 Australian species, one of which has also been recorded from New Guinea.

Microtis (*Orchidaceae*). A small genus, mostly Australian but said to range from New Zealand and New Caledonia over Malaysia to India. Its occurrence in New Guinea apparently rests on a little-known plant which has been called *M. papuana*.

Mitrasacme (*Loganiaceae*). A genus mostly Australian but also in New Caledonia and New Zealand. Represented in New Guinea by the wide Indomalaysian *M. nudicaulis* and by an otherwise Australian species, *M. elata*.

Myoporum (*Myoporaceae*). A genus of about 30 species ranging from south-east Asia to Australia, New Zealand, Hawaii, Rapa and Rarotonga, and with an outlying species in Mauritius. More than half the species are in Australia, and New Zealand has only one. It is represented in New Guinea by *M. papuanum*, presumably endemic, and by *M. tenuifolium* which is also in New Caledonia and Queensland.

Olearia (*Compositae*). A genus of more than 100 species, nearly all of them in Australia and New Zealand in the proportion of two in the former to one in the latter. About a dozen endemics have been described from New Guinea and their affinities call for examination.

Patersonia (*Iridaceae*). A genus of about 20 species, all Australian except for one in Borneo and the Philippines and one in New Guinea, *P. novoguineensis*.

Pimelea (*Thymelaeaceae*). A genus of about 80 species, predominantly Australian but with 15 species in New Zealand, and known also from Timor and Lord Howe Island. It is presumably one of the Australian species which has recently been reported from New Guinea.

Pittosporum (*Pittosporaceae*). This large and widespread genus of the Old World has its heaviest concentrations of species in New Zealand and New Caledonia, but lesser ones in Australia, the Philippines, Madagascar and Hawaii. The *Flora Malesiana* gives 5 species for New Guinea, two of them endemic (various others have been described) and only one of the other three in common with Australia.

Pterostylis (*Orchidaceae*). Nearly all the 90 or so species of this genus are in Australia and New Zealand, but there are also two in New Caledonia and two in New Guinea.

Ptilotus (*Amaranthaceae*). A characteristic Australian genus with about 70 species, one of which, *P. conicus*, occurs in parts of Malaysia and has recently been reported from New Guinea.

Ripogonum (*Smilacaceae*). A small genus with two groups, in one of which there are 4 Australian species, one common to Australia and New Guinea, and one endemic to New Guinea. In the other there is a single well-known New Zealand species.

Scaevola (*Goodeniaceae*). A characteristic Australian genus of about 100 species, two of which are widespread tropical strand-plants. There are a few species in New Caledonia, and perhaps in Polynesia, and two endemics have been described from New Guinea, though one may not be so.

Schelhammera (*Liliaceae*). A genus of two Australian species, one of which, *S. multiflora*, was long ago recorded from New Guinea.

Schoenus (*Cyperaceae*). Another widespread genus of sedges, with most of its 65 species in Australia. Two endemics and several wides are recorded from New Guinea.

Stackhousia (*Stackhousiaceae*). All but one of the 25 species are Australian, and there is another only in New Zealand. One of the Australian species is found also in New Guinea, Sumatra, Celebes, the Philippines, the Moluccas and Micronesia.

Stylidium (*Stylidiaceae*). A large and characteristic Australian genus of about 100 species, with a thin but wide representation over Indomalaysia. Two species occur in New Guinea—*S. alsinoides* of northern Australia, Celebes and the Philippines, and *S. schizanthum* of northern Australia and the Fly River area of New Guinea.

Thelymitra (*Orchidaceae*). A genus characteristic of Australia (45 species) and New Zealand

(20 species) but with four other species in New Guinea, New Caledonia, Timor and Java respectively. The New Guinea endemic is said to be most closely allied to some of the New Zealand species.

Thysanotus (*Liliaceae*). A characteristic Australian genus of about 20 species. Of the two species recorded from New Guinea one is also in Australia, and the other is distributed from Australia to south-east Asia.

Trachymene (*Umbelliferae*). A somewhat confused genus with most of its 26 species in Australia. New Guinea has 8 endemics, one species found also in Celebes, and one found also in Australia, Borneo and the Philippines. There is also an endemic species in New Caledonia.

Tricoryne (*Liliaceae*). An Australian genus of some six species. One of these, *T. platyptera*, has recently been recorded from southern New Guinea.

Velleia (*Goodeniaceae*). One species of the 18 in this Australian genus, *V. spathulata*, has been recorded from south-east New Guinea.

A careful study of the facts in the above review reveals several interesting features which serve to diminish rather than to enhance the importance of these " Australian " genera in the flora of New Guinea. Thus :

1. The total number of New Guinea endemic species in *all* these genera is only 64 and nearly half of these are in *Olearia, Trachymene, Haloragis, Cladium* and *Helichrysum*. Such wide and characteristic Australian genera as *Acacia, Banksia, Drosera, Epacris, Gompholobium, Haemodorum, Hibbertia, Lechenaultia, Lomandra, Pimelea, Ptilotus, Stackhousia, Stylidium, Thelymitra* and *Thysanotus* have none : *Eucalyptus, Grevillea* and *Myoporum* have only one each ; *Casuarina* only two.

2. 16 out of the 62 genera are in Australia and New Guinea *only*. These have only 7 New Guinea endemics between them, compared with upwards of 300 in Australia.

3. Several of the genera, e.g. *Stackhousia* and *Stylidium*, have one or more species fairly widely distributed in Indomalaysia, and most of these genera are represented in New Guinea only by one or more such species.

4. Several of the genera, e.g. *Cladium, Drosera* and *Schoenus*, are very widespread and " Australian " only in the arbitrary sense used here that their species concentration is greatest in the continent of Australia.

5. Most of the genera represented in New Guinea only by a single Australian species, e.g. *Caesia, Cleistochloa, Drakaea, Ectrosia, Gompholobium, Pimelea, Ptilotus* and *Tricoryne*, are of recent report and are possibly introduced.

6. It will be noted that the names of New Caledonia and of New Zealand recur with notable frequency. Of the 62 genera, 6 occur in New Zealand—*Centrolepis, Leptocarpus, Olearia, Pimelea, Ripogonum* and *Stackhousia* : 13 occur in New Caledonia—*Acacia, Baeckea, Casuarina, Dodonaea, Flindersia, Geijera, Geitonoplesium, Grevillea, Hibbertia, Lomandra, Melaleuca, Scaevola* and *Trachymene* ; and 17 occur in *both*—*Arthropodium, Brachycome, Cladium, Drosera, Epacris, Exocarpus, Gahnia, Haloragis, Helichrysum, Lepidosperma, Microtis, Mitrasacme, Myoporum, Pittosporum, Pterostylis, Schoenus* and *Thelymitra*.

7. There is much still to be learnt about the distribution of these 62 genera within New Guinea but it can be said that few if any of their members are among the more widespread or important plants in the New Guinea flora. Some of them have a very restricted range there, and others occur only in those areas most closely adjacent to Australia.

g. Remaining non-endemic genera

These number about 126 and can be divided into three sub-categories :

1. Balanced genera of Australia and New Guinea

These are 18 small genera, entirely or virtually confined to Australia and New Guinea, but more or less equally balanced between the two, though, as might be expected, the actual range within Australia is often greater than in New Guinea. In 8 of them—*Cycnogeton* (included by some authors under the widespread genus *Triglochin*), *Eustrephus, Hymenosporum, Osbornia, Phacellothrix, Tecticornia, Torrenticola* and *Vandasia*—a single species occurs in both regions. *Bouchardatia, Gillbeea, Helmholtzia, Himantandra, Kissodendron* and *Piptocalyx* are generally regarded as having one species in *each* region. In *Carronia, Eupomatia* and *Pleiogynium* there are two species in one or both regions. In *Toechima* there are four species in Australia and four in New Guinea.

2. Southern, and mostly predominantly temperate, genera

In total these number 24 and it is of great interest that so many should occur in such equatorial latitudes as New Guinea. Moreover these are mostly genera much more characteristic of, and well represented in, New Zealand than Australia, e.g. *Coprosma* and *Hebe*. The most typical of this sub-category are *Abrotanella, Acaena, Astelia, Carpha, Coprosma, Drapetes, Drimys, Gaimardia, Gunnera, Hebe, Lagenophora, Libertia, Muehlenbeckia, Nertera, Nothofagus, Oreobolus, Oreomyrrhis, Pratia, Uncinia* and *Vittadinia*. The two Proteaceous genera *Gevuina* and *Oreocallis* are unlike all the rest in being absent from New Zealand. More anomalous but best included in this sub-category are *Iphigenia* and *Metrosideros* both of which occur in Africa but not in America. *Metrosideros* offers special problems because it is very much a New Zealand genus, but has only a single tropical species in Australia and only a single species in South Africa, where it has no close relatives.

3. Remainder

The geographical distribution of the remaining 84 non-endemic genera is not only extremely varied, especially in respect of Melanesia, but in some cases is still not properly known. They are all alike however in being generally restricted to an area comprising the Philippines, the Moluccas, Celebes, Timor and the Lesser Sunda Islands, north-east Australia, the Solomons, the New Hebrides, Fiji, Polynesia, Micronesia, New Caledonia and New Zealand, though occasionally and anomalously a genus may occur somewhere outside these limits.

Within this general category four groups can be recognized fairly easily. Ten genera may be described as subendemic to New Guinea, being found, elsewhere, only in Australia or the Bismark Archipelago, or occasionally in both. The genera which appear to have this distribution are *Epiblastus, Hydriastele, Kentia, Levieria, Linospadix, Mackinlaya, Neosepicaea, Peekeliopanax, Tripetalum* and *Trochocarpa*. Twenty others are *not*, outside New Guinea, found east of New Guinea/Australia. These are *Althoffia, Ascoglossum, Calymmanthera, Calyptrocalyx, Camptostemon,*

Coelopyrena, Cominsia, Gronophyllum, Heterospathe, Kjellbergiodendron, Lepiniopsis, Mearnsia, Merrilliodendron, Palmeria, Pseudotrophis, Ptychandra, Rhopaloblaste, Scaphiophora, Schizomeria and *Steganthera.* Another 18 genera occur, outside New Guinea, *both* west and east of New Guinea/Australia, namely *Archidendron, Ascarina, Badusa, Corynocarpus, Couthovia, Dolicholobium, Drymophloeus, Gulubia, Haplolobus, Mastixiodendron, Microlaena, Paratrophis, Santalum, Soulamea, Wenzelia, Xanthostemon* and anomalously, since they are reported from Borneo, *Durandea* and *Faradaya.*

Finally there are 36 genera which, outside New Guinea, occur *only* east of New Guinea/Australia. These are particularly varied in distribution but almost every one of them is of particular interest in some way or other from the point of view of the flora of New Guinea. The following list of them will, it is hoped, enable anyone wishing to study them further to do so more easily—*Acianthus, Ackama, Agatea, Airosperma, Amyema, Antholoma, Astronidium, Batis, Belliolum, Bubbia, Calochilus Carpodetus, Cupaniopsis, Dallachya, Delarbrea, Dubouzetia, Euroschinus, Eurycentrum Finschia, Halfordia, Hedycarya, Meryta, Moerenhoutia Plerandra, Pseudomorus, Ptychococcus, Ptychosperma, Pullea, Raoulia, Sararanga, Sphenostemon, Spiraeanthemum, Stenocarpus, Tapeinosperma, Trimenia, Tupeia.*

It may be added that of the 54 genera in the last two groups 25 occur in Australia ; 26 in New Caledonia ; 15 in Fiji ; and 11 in New Zealand.

h. Endemic genera

As already stated there is no endemic family in the New Guinea flora. The endemic genera appear to number about 140, and to represent about 50 families, and the number of species in them is some 355. Ninety of the genera are monotypic, and the average number of species per genus is 2·5 (see Table I). Only seven genera have more than 10 species, namely *Paralinospadix* (21), *Rhyticaryum* (20), *Chitonanthera* (19), *Nengella* (19), *Sericolea* (16), *Cyrtandropsis* (15) and *Symbegonia* (12.)

The Numbers of Species

The lack of a complete published Flora of New Guinea is particularly felt when questions about the numbers of species arise. It is true that many species figures have been quoted in the foregoing pages, but this has only been to enable some comparison to be made between different genera, and the figures are not claimed to be definitive in any way. There are, however, two figures of such special interest that some definite attempt must be made to arrive at them. These are the total number of indigenous species in the flora, and the proportion of endemics among them.

As regards endemics the situation is easier because the *Index Kewensis* at least tells us how many in total *have been described,* and it only remains to decide in what measure this is an accurate reflection of the facts. It is likely in some large genera, such as various of the orchids, that there is considerable duplication, because new species have been described concurrently by workers in different countries, but against this it is noticeable that when a genus with a reasonably large number of species is carefully revised and monographed new species, hitherto unrecognized, are usually discovered, and these often restore the *Index* figure by making good the

loss through synonymy. On the other hand in smaller genera represented perhaps by only one or two species in New Guinea there seems to have been a general tendency in the past to describe as endemic species forms which have later been considered no more than local versions of wide species. A further point to remember is that there are certainly many new species yet to be described, though the number of these is an imponderable.

Weighing these considerations together it would seem that the total of endemic species as shown in the *Index Kewensis*—up to and including the recently published Twelfth Supplement (1959)—is probably sufficiently near the truth to be acceptable in general terms. This figure is nearly 8,500 (see Table I).

The wide species are more troublesome to estimate because they can only be assembled by searching through the scattered literature, and also because the number of names under which they appear is greater. Their estimation is also greatly confused by the problem of status, and there is reason to suspect that some of the widespread species do in fact owe their presence in New Guinea to human influence. It is therefore difficult to come to any very definite conclusion as to the number of these species but the indications suggest that the proportion of the wide species in the flora is between 5 and 10 per cent, and possibly nearer the latter than the former.

These two figures give an overall figure for the indigenous flora of New Guinea as a whole of about 9,000–9,250, a notably high figure in comparison with many other areas of similar size.

Not unnaturally the proportion of specific endemism varies greatly in the different families. There are at least 60 families with no endemics at all. These are mostly aquatics, strand or mangrove plants, or parasites, but they appear to include also

Table I

Summary of geographical generic categories and endemic species

	Total genera	Genera with endemic species	Total endemic species	Col. 3 / Col. 1	Col. 3 / Col. 2
a. Widespread genera	86	54	579 (128)	6·7	10·7
b. Pantropical genera	244	156	2,338 (689)	9·6	15·0
c. Palaeotropical genera	169	107	829 (125)	4·9	7·7
d. Asiatic-American genera	27	21	184 (9)	6·8	8·8
e. Indomalaysian genera	494	250	3,576 (1,565)	7·2	14·3
f. Australian genera	62	24	64 (4)	1·0	2·7
g. Other non-endemic genera	126	87	538 (50)	4·3	6·2
h. Endemic genera	140	140	355 (50)	2·5	2·5
TOTALS	1348	839	8,463	6·2	10·0

The figures in parentheses are those of the *Orchidaceae* only and in *a* include *Liparis* with 76, and in *b Bulbophyllum* with 558 and *Malaxis* with 89.

Table II

Geographical categories of the genera in the families represented in the New Guinea flora by more than twelve genera

The highest figure in each family is underlined

	Total Genera	Introductions	Widespread	Pantropical	Palaeotropical	Asia-America	Indomalaysian	Australian	Other wides	Endemic	
Orchidaceae	128	–	6	7	9	1	75	4	9	17	
Gramineae	113	31	11	30	12	2	21	2	1	3	
Leguminosae	82	18	–	34	8	1	14	2	2	3	
Rubiaceae	63	1	1	14	10	2	20	–	8	7	
Compositae	62	40	5	1	1	1	1	3	5	5	
Euphorbiaceae	44	5	1	6	10	–	18	1	–	4	
Palmae	33	1	–	–	2	–	13	–	12	5	
Apocynaceae	30	5	–	2	4	–	10	–	2	7	
Myrtaceae	29	1	–	4	–	–	8	6	5	5	
Sapindaceae	28	2	–	1	2	1	17	1	2	2	
Acanthaceae	27	2	–	8	6	–	4	–	–	7	
Melastomataceae	27	–	–	–	3	–	16	–	1	7	
Annonaceae	24	1	–	2	3	–	12	–	–	6	
Cyperaceae	24	–	5	8	–	–	3	4	3	1	
Rutaceae	22	1	–	1	3	–	7	2	3	5	
Araceae	21	–	–	2	1	2	13	–	–	3	
Asclepiadaceae	21	5	–	1	6	–	6	–	–	3	
Menispermaceae	21	–	–	1	1	–	14	–	1	4	(only 31 spp. in all)
Moraceae	19	3	–	1	1	–	8	–	3	3	
Scrophulariaceae	18	4	2	3	4	–	3	–	1	1	
Anacardiaceae	17	2	–	3	2	–	5	–	2	3	
Zingiberaceae	17	1	–	2	2	–	11	–	–	1	
Araliaceae	16	–	–	1	2	–	5	–	6	1	
Loranthaceae	16	–	–	–	2	1	4	–	9	7	
Sterculiaceae	16	2	–	3	4	–	5	2	–	–	
Cucurbitaceae	15	8	–	1	2	–	4	–	–	–	
Myrsinaceae	15	–	–	2	4	–	6	–	1	2	
Urticaceae	15	–	1	4	4	–	5	–	–	1	
Verbenaceae	15	4	–	3	2	–	4	–	1	1	
Flacourtiaceae	14	2	–	3	3	–	5	–	–	1	
Gesneriaceae	14	–	–	–	1	–	9	–	–	4	
Icacinaceae	14	–	–	–	2	–	8	–	1	3	
Labiatae	14	14	–	–	–	–	–	–	–	–	
Meliaceae	14	1	–	–	1	–	12	–	–	–	
Convolvulaceae	13	11	–	–	1	–	1	–	–	–	
Lauraceae	12	–	–	3	1	–	7	–	–	1	

the *Chenopodiaceae, Chloranthaceae, Droseraceae, Juncaceae, Lythraceae, Malpighiaceae* and *Simaroubaceae*, as well as a group of Australian families.

The great majority of endemics are thus found in only about 150 of the families, and here again the figures vary widely. For instance the proportion of endemics is unusually low in *Gramineae* (c. 50 per cent), *Sterculiaceae* (65 per cent), *Leguminosae* (70 per cent), *Cyperaceae* (75 per cent) and *Menispermaceae* (75 per cent). On the other hand *Acanthaceae, Anacardiaceae, Annonaceae, Apocynaceae, Araceae, Araliaceae, Asclepiadaceae, Gesneriaceae, Icacinaceae, Meliaceae, Myrsinaceae, Myrtaceae, Palmae, Rubiaceae, Rutaceae, Sapindaceae, Urticaceae* and *Zingiberaceae* probably have more than 95 per cent of endemics. In the *Orchidaceae* only about half-a-dozen species out of 2,600 appear to be wides. Finally it may be that in *Cunoniaceae* (65 species), *Elaeocarpaceae* (186), *Ericaceae* (311), *Lauraceae* (144), *Monimiaceae* (80), and possibly one or two others, *all* the species are endemic.

Further Australasian relationships of the New Guinea flora

Although the particular interest of the indigenous flora of New Guinea lies in the nature and degree of its relationships with the flora of the continent of Australia, its relations with the floras of certain other parts of Australasia, notably Tasmania, New Zealand and New Caledonia, are almost equally important, and this study may appropriately be concluded with a brief comparative presentation of the relationships between all these five at generic level.

Of the 1,350 or so indigenous genera of the New Guinea flora :

a. Over 700 (more than 50 per cent) are members also of the flora of continental Australia ;
b. About 385 (some 30 per cent) are members also of the flora of New Caledonia ;
c. About 165 (some 13 per cent) are members also of the flora of New Zealand ;
d. About 150 (11 per cent) are members also of the flora of Tasmania ;
e. About 120 occur in the floras of *both* New Zealand *and* Tasmania.

About 60 genera occur in all the five regions, namely New Guinea, Australia, Tasmania, New Caledonia and New Zealand. Rather naturally these include many very widespread genera but among the others there may be mentioned *Arthropodium, Astelia, Brachycome, Dianella, Elaeocarpus, Erechthites, Exocarpus, Gahnia, Lagenophora, Libertia, Mitrasacme, Muehlenbeckia, Myoporum, Nertera, Parsonsia, Pittosporum, Thelymitra* and *Uncinia*. In *Astelia* the continental Australian distribution is limited to the extreme south-east.

The genera which occur in New Guinea and also in three out of the four other regions mentioned number about 90, the largest group being that in which the genera are present in New Guinea, Australia, Tasmania and New Zealand but absent from New Caledonia. The 40 or so genera here not unnaturally include many widely distributed temperate genera such as *Lobelia, Epilobium* and *Ranunculus*, but also some southern genera, among them *Acaena, Drimys, Hebe* and *Nothofagus*.

The genera which are in New Guinea, Australia, New Caledonia and New Zealand, but which are absent from Tasmania, number 28. Most of them are tropical genera

which occur chiefly in the North Island of New Zealand but which do not reach the latitude of Tasmania, as, for example, *Avicennia*, *Freycinetia*, *Hedycarya* and *Peperomia*.

The genera which are in New Guinea, Australia, Tasmania and New Caledonia, but which are absent from New Zealand, number 18, of which perhaps the most noteworthy are *Acacia*, *Casuarina*, *Grevillea*, *Hibbertia* and *Xyris*.

There appear to be no genera which occur in New Guinea, New Caledonia, New Zealand and Tasmania, but not on the Australian mainland, the nearest approach perhaps to one being *Astelia*, already mentioned.

Finally it is worthwhile to set out the *difference* between Tasmania and New Zealand in respect of their floristic relations with New Guinea. There are in Tasmania 33 genera which occur also in New Guinea but which are not found in New Zealand, namely :

*Acacia**	*Gompholobium*	*Phyllanthus*
Alyxia	*Grevillea*	*Posidonia*
Baeckea	*Haemodorum**	*Psoralea*
Banksia	*Halophila*	*Stylidium**
Caesia	*Hemarthria*	*Thismia**
Casuarina	*Hibbertia*	*Thysanotus*
Cryptostylis	*Indigofera*	*Trachymene*
Cynoglossum	*Lepturus*	*Trochocarpa*
Desmodium	*Melaleuca*	*Vallisneria*
Dipodium	*Patersonia*	*Velleia*
*Eucalyptus**	*Phragmites*	*Xyris*

Of these only the five starred have endemic species (13 in all) in Tasmania.

On the other hand there are in New Zealand 46 genera which are also in New Guinea but which are not found in Tasmania, namely :

*Ackama**	*Fimbristylis*	*Peperomia*
*Alectryon**	*Freycinetia**	*Phrygilanthus**
(*Aleurites*)	*Geniostoma**	*Piper*
*Ascarina**	*Hedycarya**	*Potentilla*
Avicennia	*Hibiscus*	*Planchonella**
*Beilschmiedia**	(*Homalanthus*)	*Pratia**
(*Boehmeria**)	*Iphigenia**	*Ripogonum**
*Bulbophyllum**	*Isachne*	*Quintinia**
Calpidia	*Litsea**	*Schefflera**
(*Canavalia*)	*Melicope**	*Sophora**
*Carpodetus**	*Meryta**	*Sparganium*
*Cordyline**	*Metrosideros**	*Tupeia*
*Coriaria**	*Myrtus**	*Vitex**
*Corynocarpus**	*Panicum*	*Weinmannia**
*Dysoxylum**	*Paratrophis**	
*Elatostema**	*Paspalum*	

Of these the starred genera have endemic species, totalling 66 (10 of them in *Metrosideros*) in New Zealand, while the genera in parentheses occur in the Kermadec Islands but not in New Zealand proper.

Summary

1. The Angiosperm flora of New Guinea, as at present known, consists of about 1,350 native genera, comprising rather more than 9,000 species in all, of which nearly 8,500, or 90 per cent, are reckoned to be endemic.

2. These genera belong to 200 families, which include all the largest of the Old World except the *Labiatae* and *Amaranthaceae*, all the species of which are under suspicion of being introduced.

3. No families are endemic to, but some are, *for their size and distribution*, especially characteristic of, and well represented in, New Guinea. These include *Araliaceae*, *Cunoniaceae*, *Elaeocarpaceae*, *Icacinaceae* and *Winteraceae*.

4. Indigenous, and especially endemic, species are proportionately very few in *Compositae*, *Cyperaceae*, *Gramineae* and *Leguminosae*, as well as in several small families.

5. The family *Orchidaceae*, on the other hand, with over 2,600 species, has four times as many as the next family, the *Rubiaceae*, which in turn has more than twice the number in *Myrtaceae* and *Palmae* which come next. Virtually all the orchid species are endemic.

6. About 500, or 37 per cent, of the genera, containing about 3,650, or 42 per cent, of the endemic species, have palaeotropical, *or wider*, distributions.

7. About the same number of genera (500), containing almost the same number of endemic species, are Indomalaysian in distribution. Directionally these may be thought of as the western and northern element in the flora.

8. The corresponding Pacific, or eastern, element in the flora contains 126, or 9 per cent, of the genera, with 538, or 6 per cent, of the endemic species.

9. The corresponding Australian, or southern, element in the flora contains 62, or 4.5 per cent, of the genera, with 64, or considerably less than 1 per cent, of the endemic species.

10. A detailed review of these 62 genera suggests that this element of the flora is of even less general consequence than these actual numbers suggest.

11. The endemic genera of the New Guinea flora number 141, or about 10 per cent of the total, but these contain only about 350 species or 4 per cent of the endemics.

12. Table II on p. 222 shows the prevalence of these geographical types in all the families represented in the flora by more than a dozen genera. It cannot usefully be summarized but careful scrutiny of it will reveal many interesting points.

13. Nearly 700 (more than 50 per cent) of the genera indigenous to New Guinea are found also in Australia. 385, or about 28 per cent, of the genera indigenous to New Guinea are found also in New Caledonia.

14. 165, or about 13 per cent, of the genera indigenous to New Guinea are found also in New Zealand, a notable proportion bearing in mind the distance apart and difference in latitude of the two. This relationship is amplified by various other more detailed items.

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